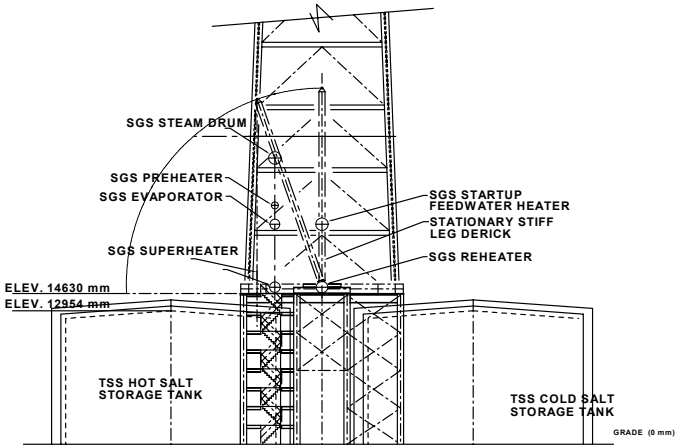

# High Temperature Molten Salt Pumps

Presented by

Daniel Barth

# Pumps Mounted in the Tanks Would Greatly Simplify the Molten-Salt System

- Eliminate the pump sumps, control and shut off valves, level instrumentation and associated heaters
- Reduce heat loss
- Allow the steam generator system to drain directly into the tanks
- Sandia National Laboratories teamed with Nagle Pumps to develop a long-shafted salt pump as part of the DOE Concentrating Solar Power Program




Desirable characteristics of bearing materials:

- Non-galling
- Low corrosion
- Easily machined
- Low cost

# Types Of High Temperature Pumps

**Vertical Cantilever Pumps:** Up to 6 Feet in Setting

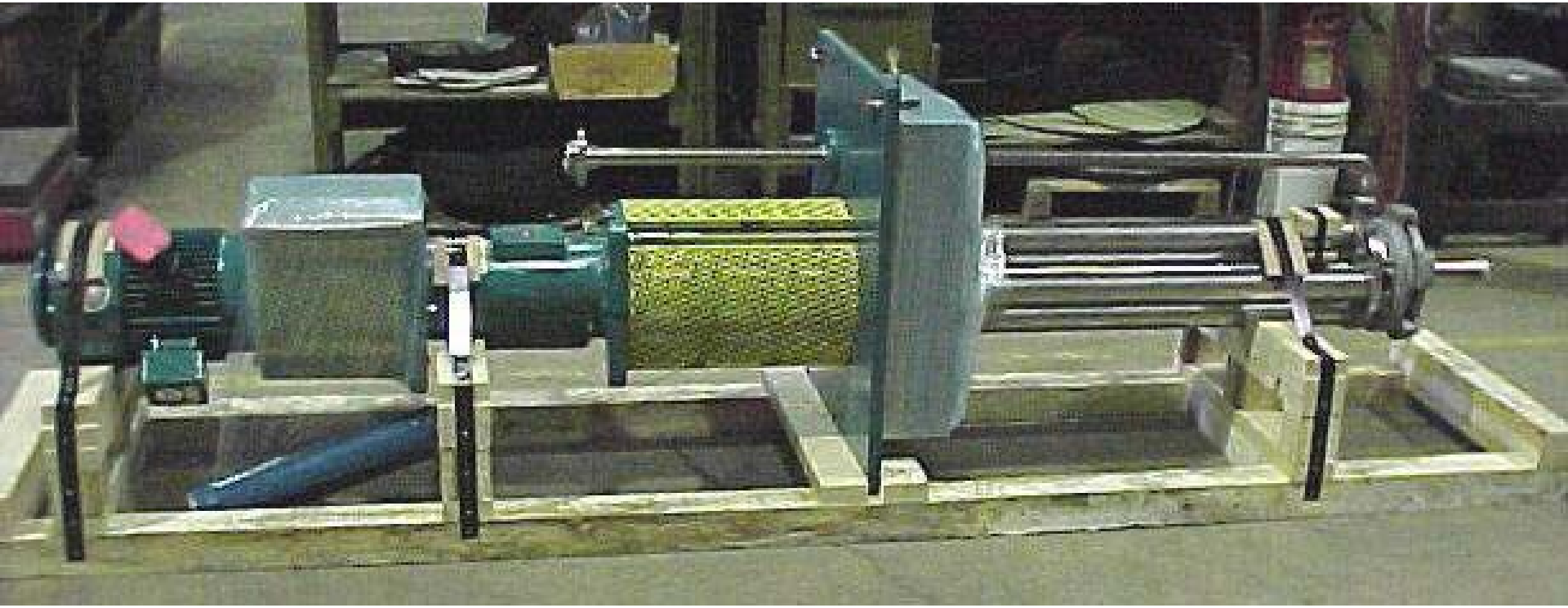
Limited Flow and Heads

**Vertical Submerged Bearing:** Up to 50 Feet in Setting

High Flow / High Heads

High Flow / Low Heads

# High Temperature Cantilever Pump



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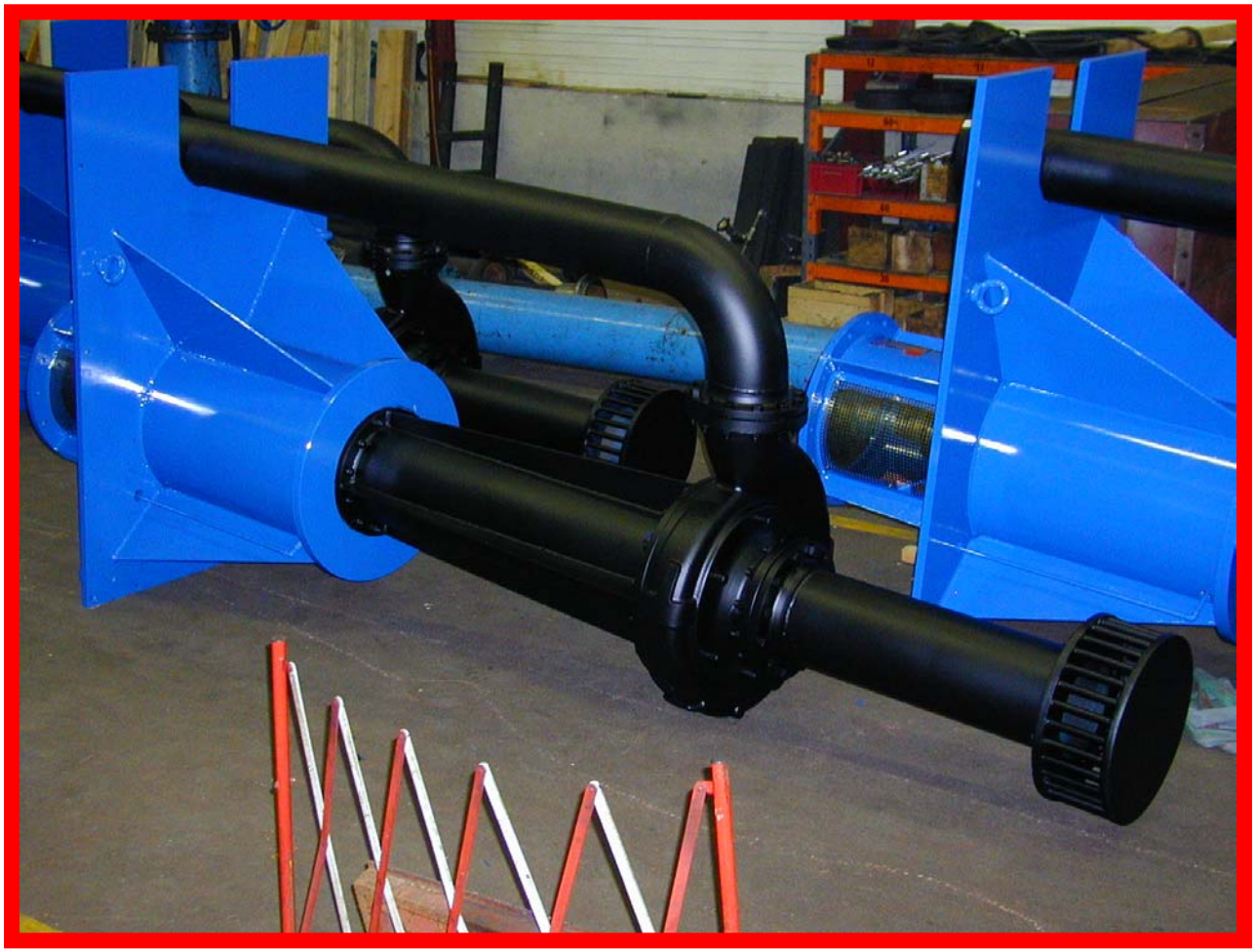
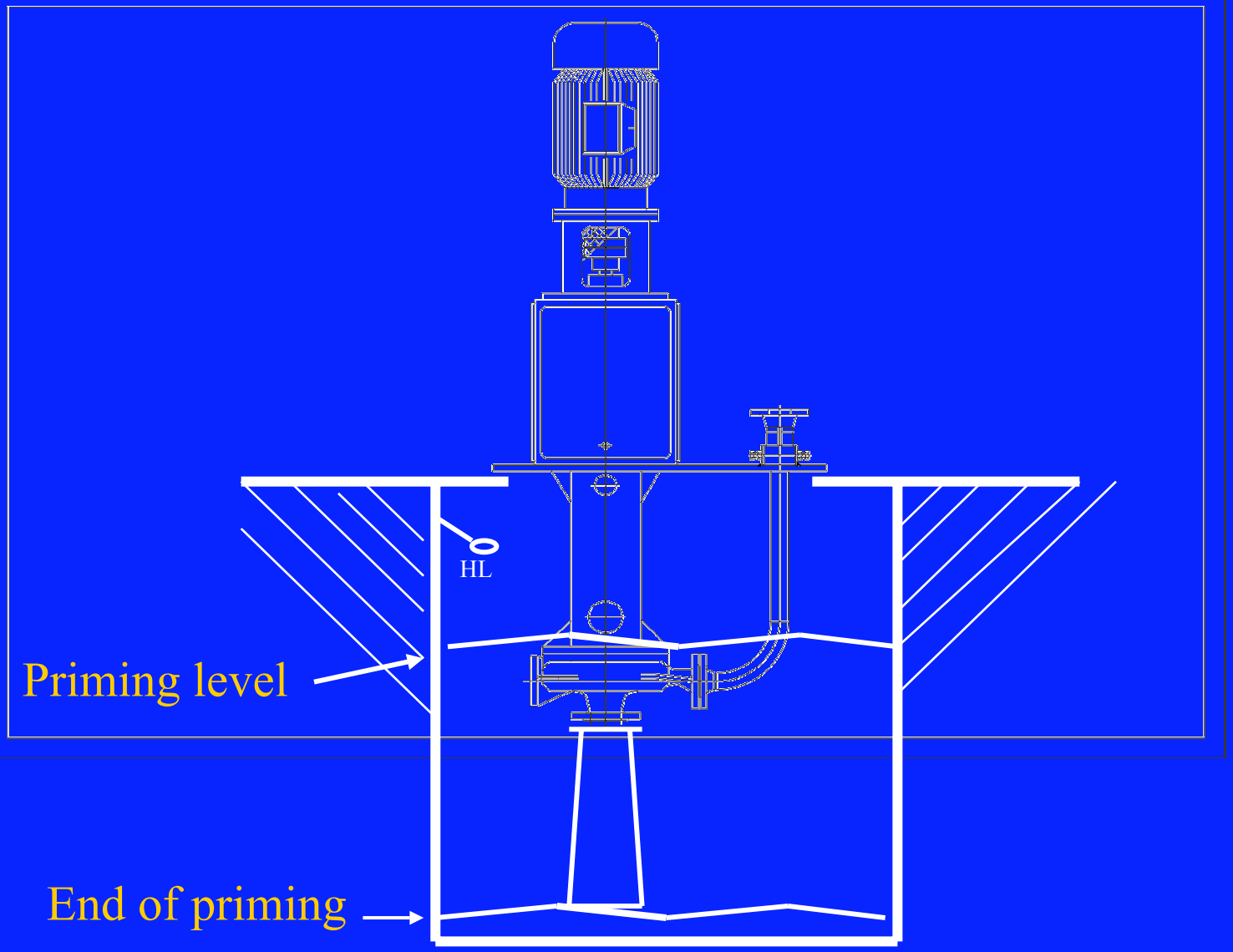
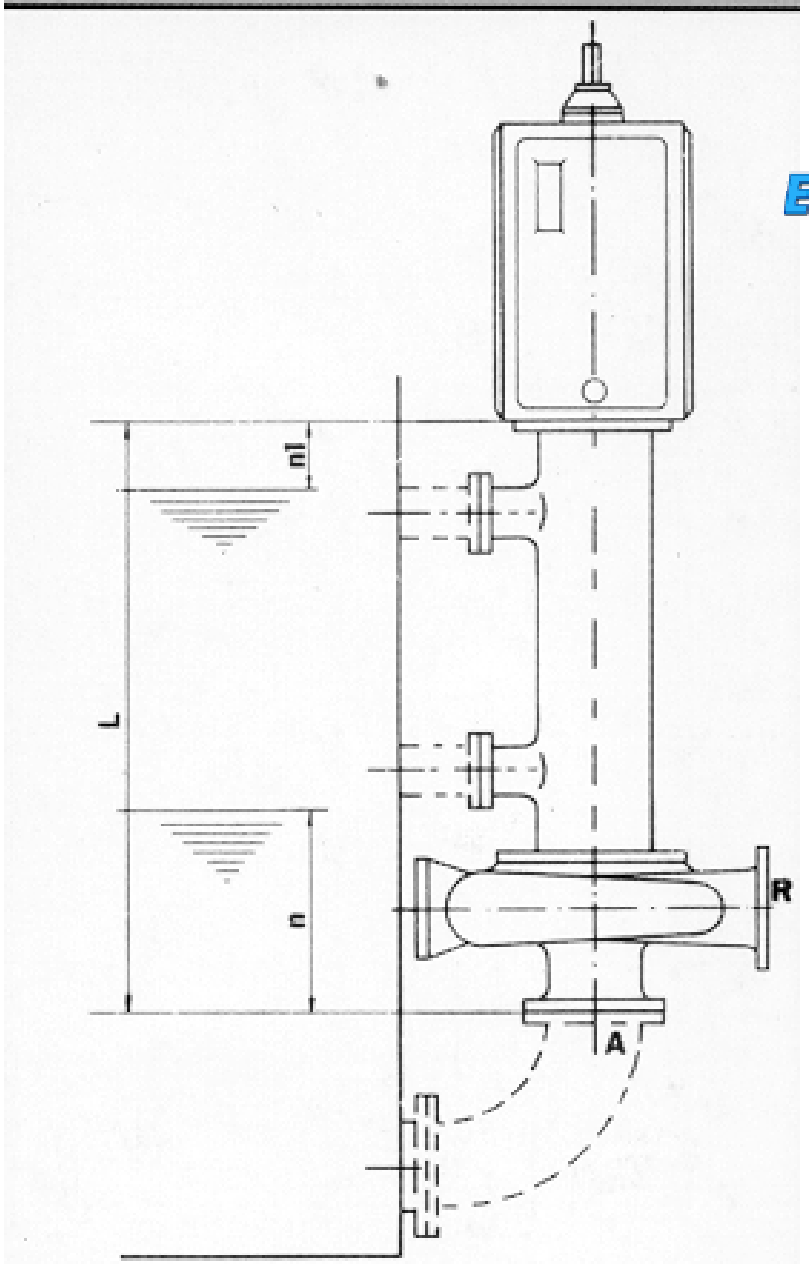


# VAP - The limits





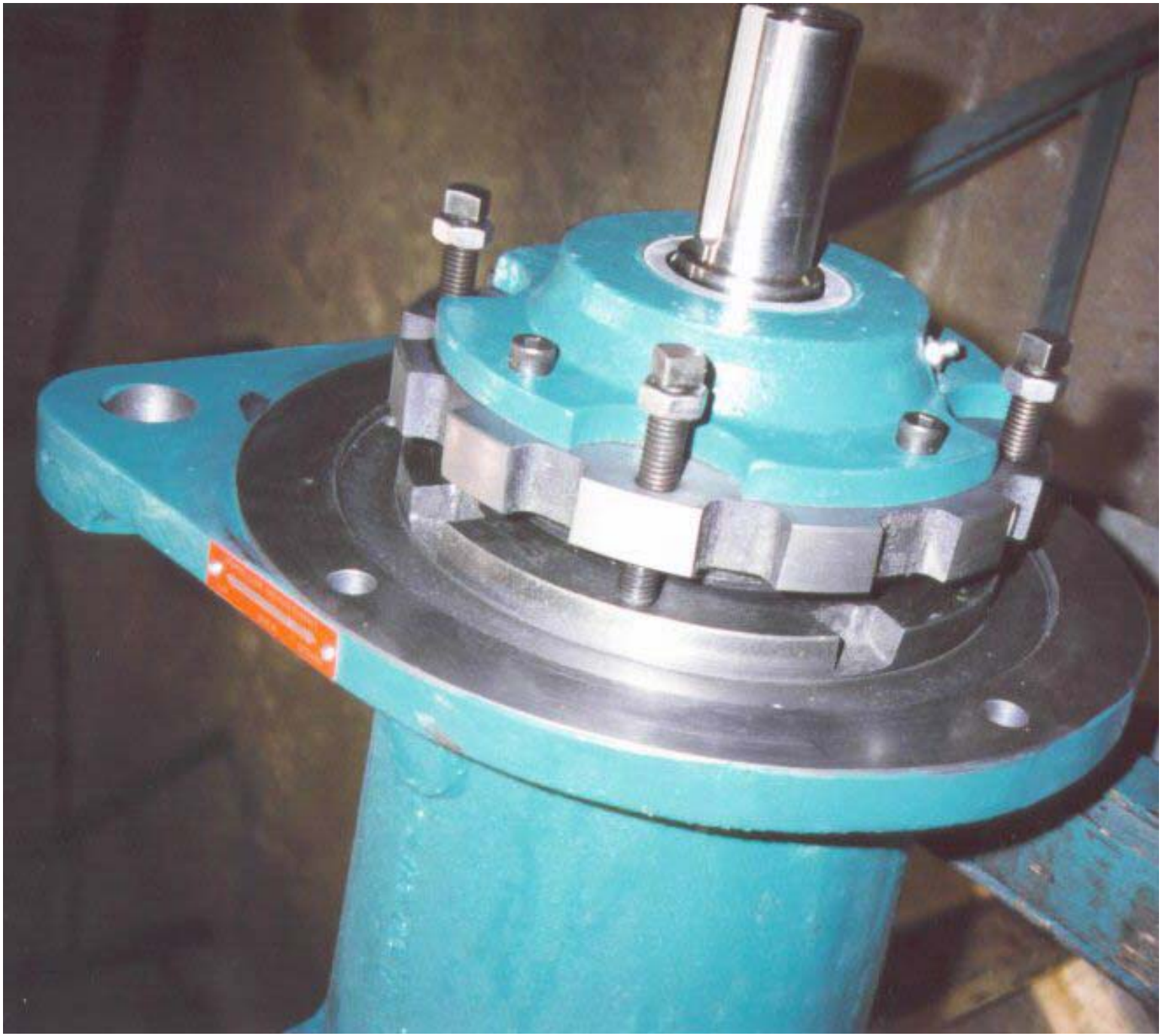

External Mounting

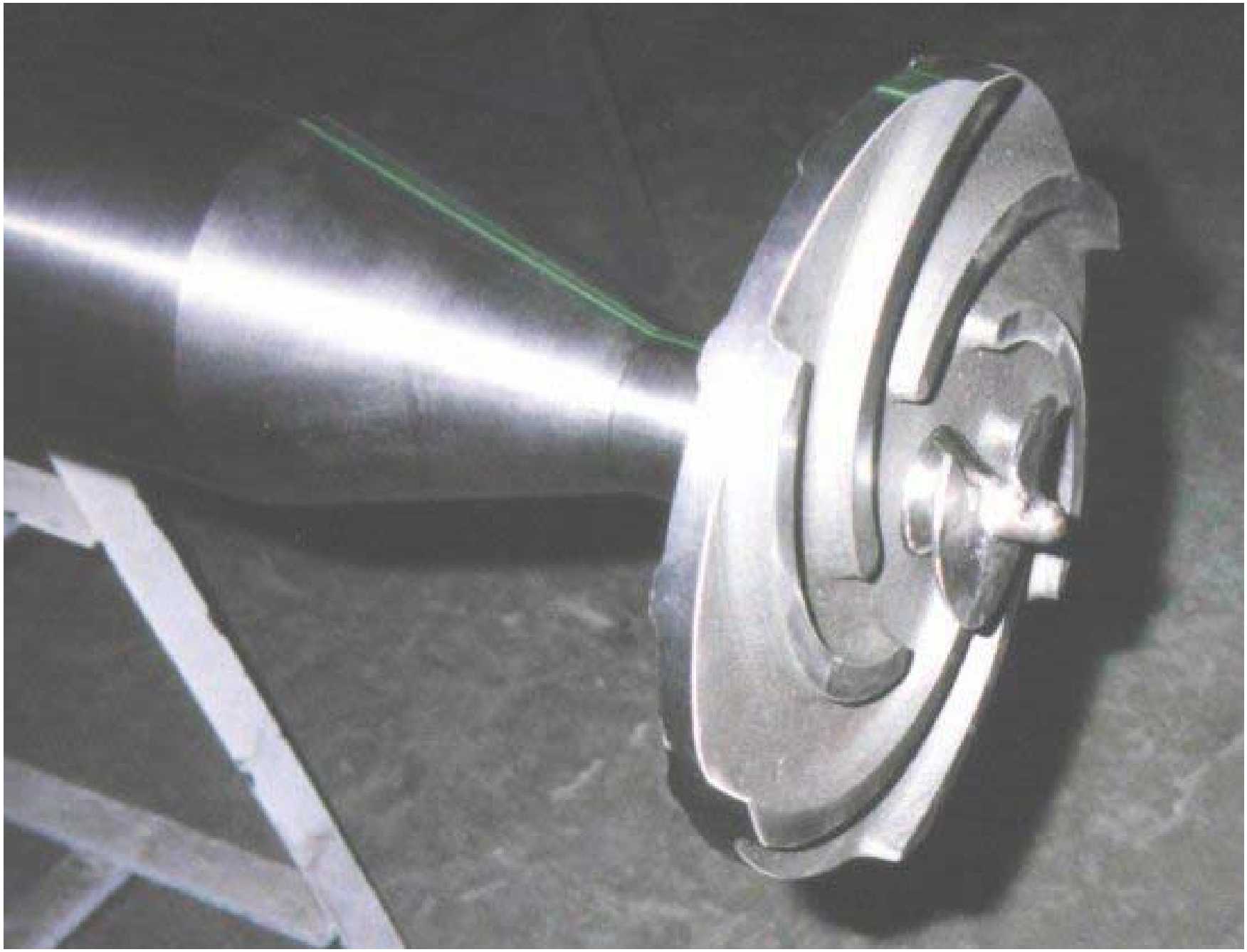
# Special Features

**Apply to both Vertical Cantilever Pumps**

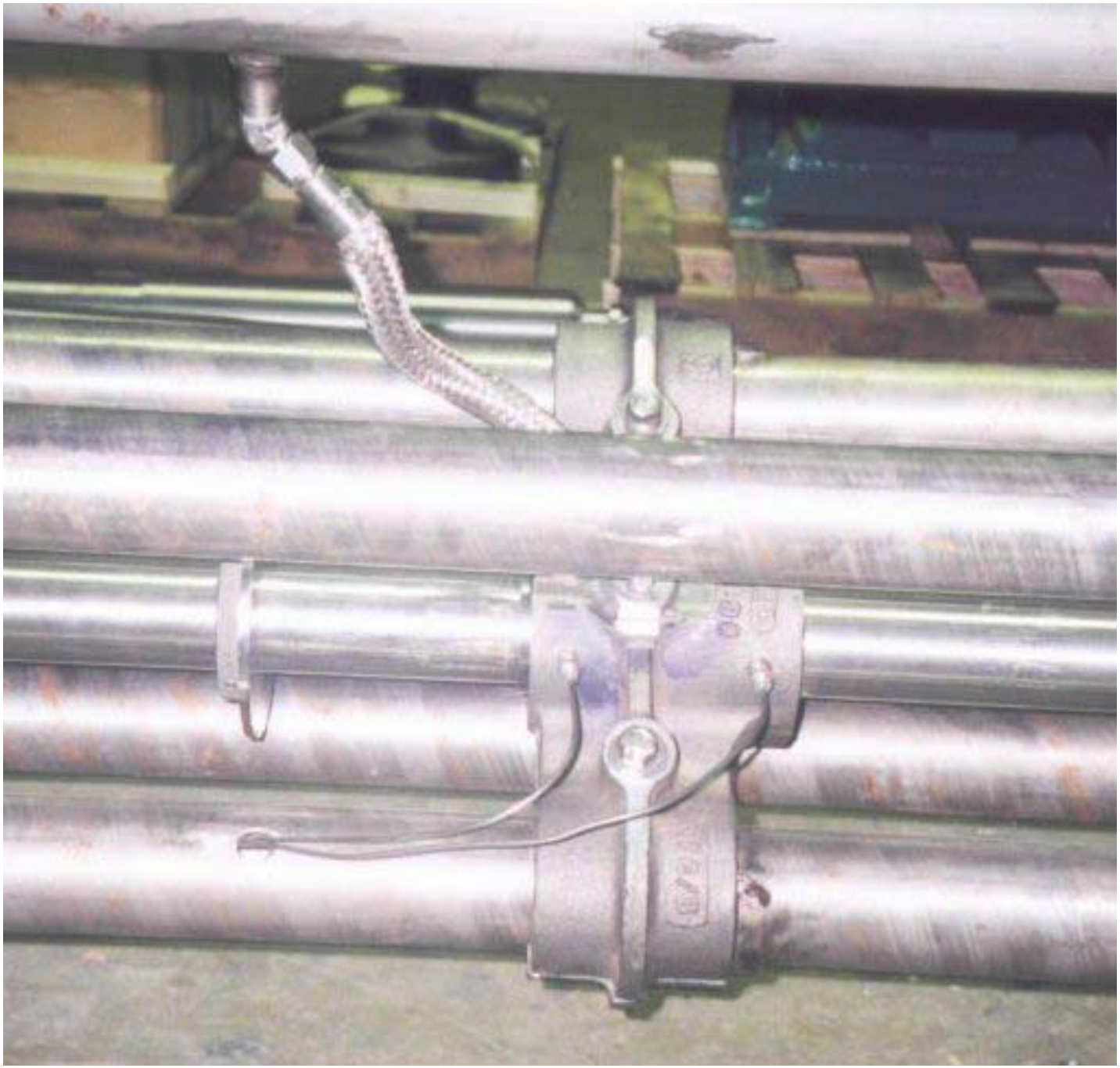
**and Vertical Submerged Bearing Pumps**

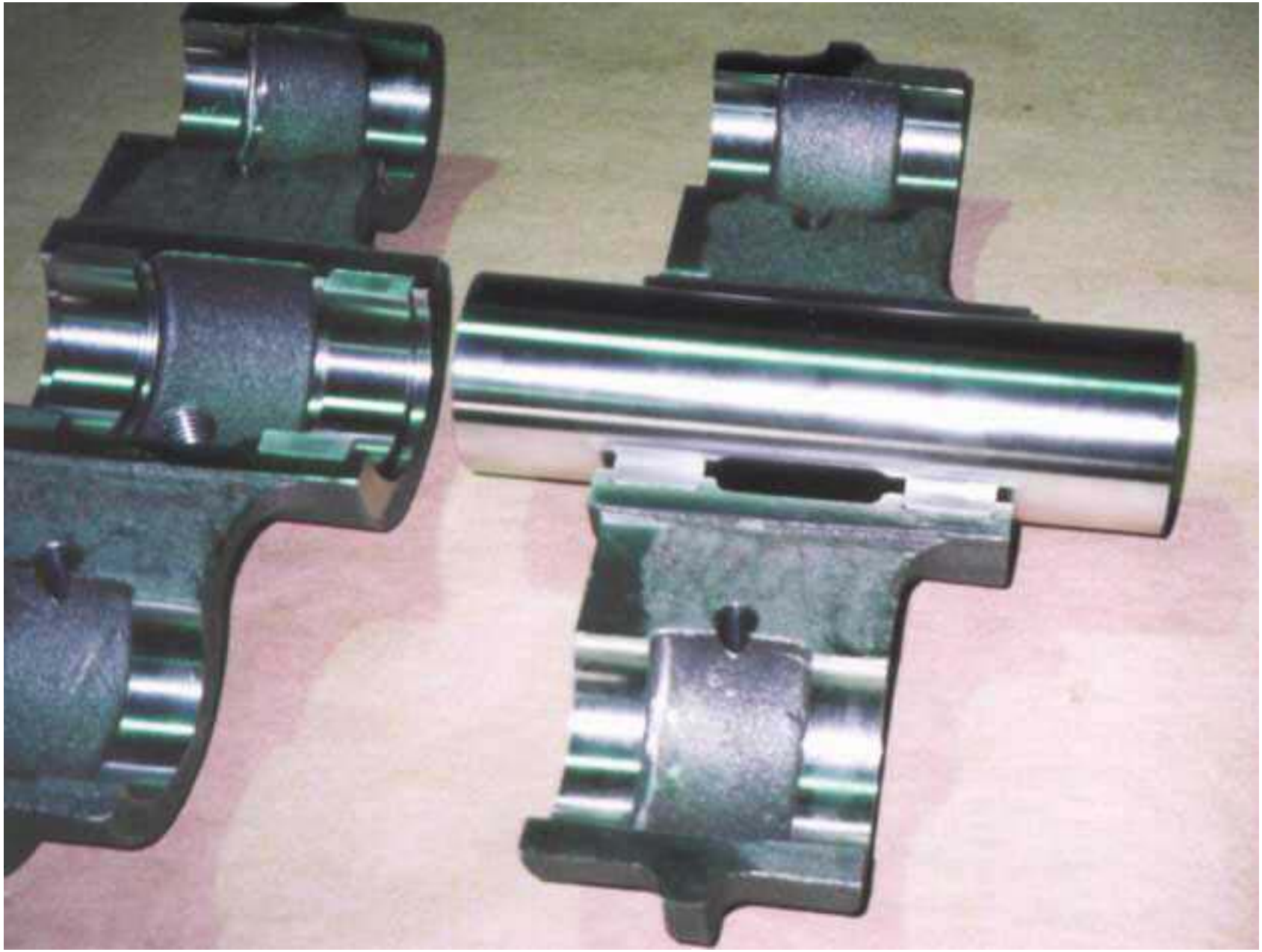
- **Impeller Adjustment From the Top of Tank**
- **Spacer Pedestal to Keep Heat From Thrust Bearings**
- **No Thrust Loads Transmitted to Motor**
- **Labyrinth Cap Seal**
- **Internal Pressure Relief of Pumpage**
- **Inducers**





# Long-Shafted Pump





# Validation Testing

**Complete validation of a High Temperature Molten Salt Pump will insure the end user a proven system that is highly reliable. By utilizing the test stand, molten salt tank and instrumentation that was used for testing the Long-Shafted Pump, the cost could be reduced greatly.**

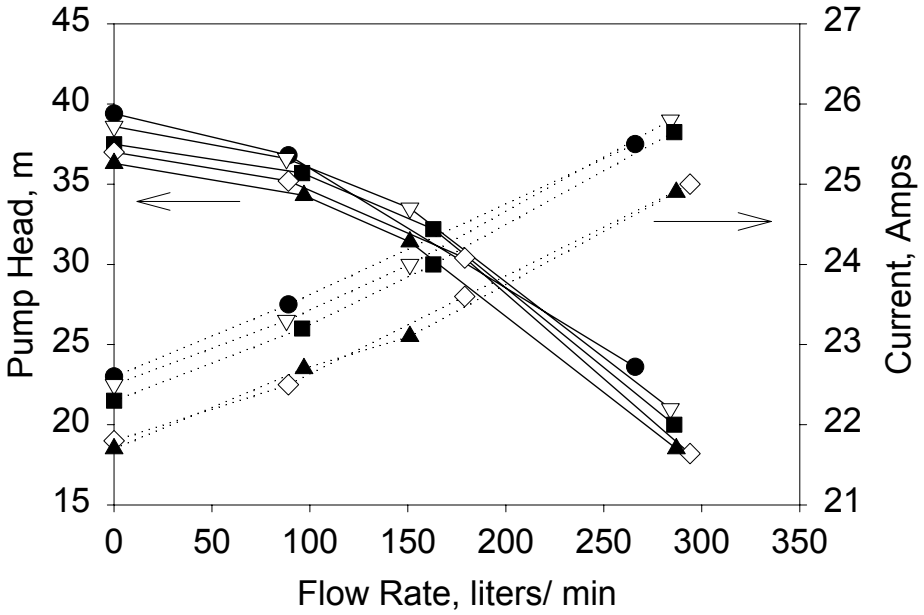
**A comprehensive testing program must be developed and approved by all major parties, both in the private sector and DOE.**

# Tests Conducted at Sandia

- Characterize the pump, simulate operating modes and operated the pump for extended time periods
- Pump head versus motor current as a function of flow rate (at 345, 400, 455, 510 and 565 deg C)
- Simulate the typical nightly shut down, drain and dry startup with a salt temperature of 565deg. C and the valve open 19%
- Endurance test: 7 hours on, 1 hour off continuously around the clock at full flow at 565 deg C.

# Test Results

- Pump curves matched design specifications
- Pump operated for over 5000 hours
- Measurements before and after showed there were no vibration problems
- After all testing was completed, the pump was disassembled, bearing and sleeve were inspected and dimensions were measured
- All bearings and sleeves were reusable, only requiring polishing of the surfaces



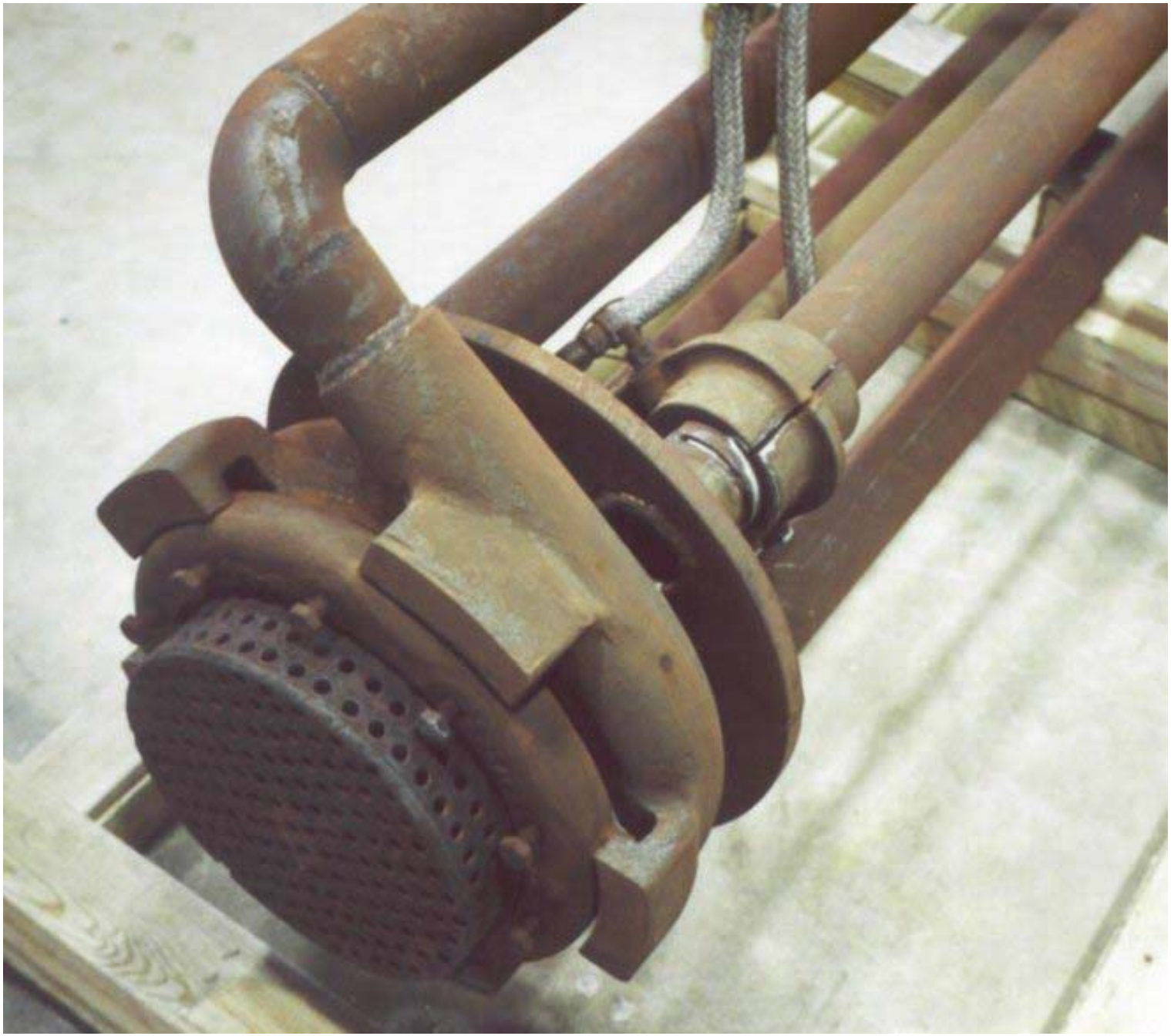
# Disassembly and Handling

~ It is critical for these units to be able to be rebuilt.

~ The design must be simplistic in order for the pumps to be rebuilt.

~ Minimum parts must be required for rebuild.

~ Maximum life between rebuilds must be obtained.

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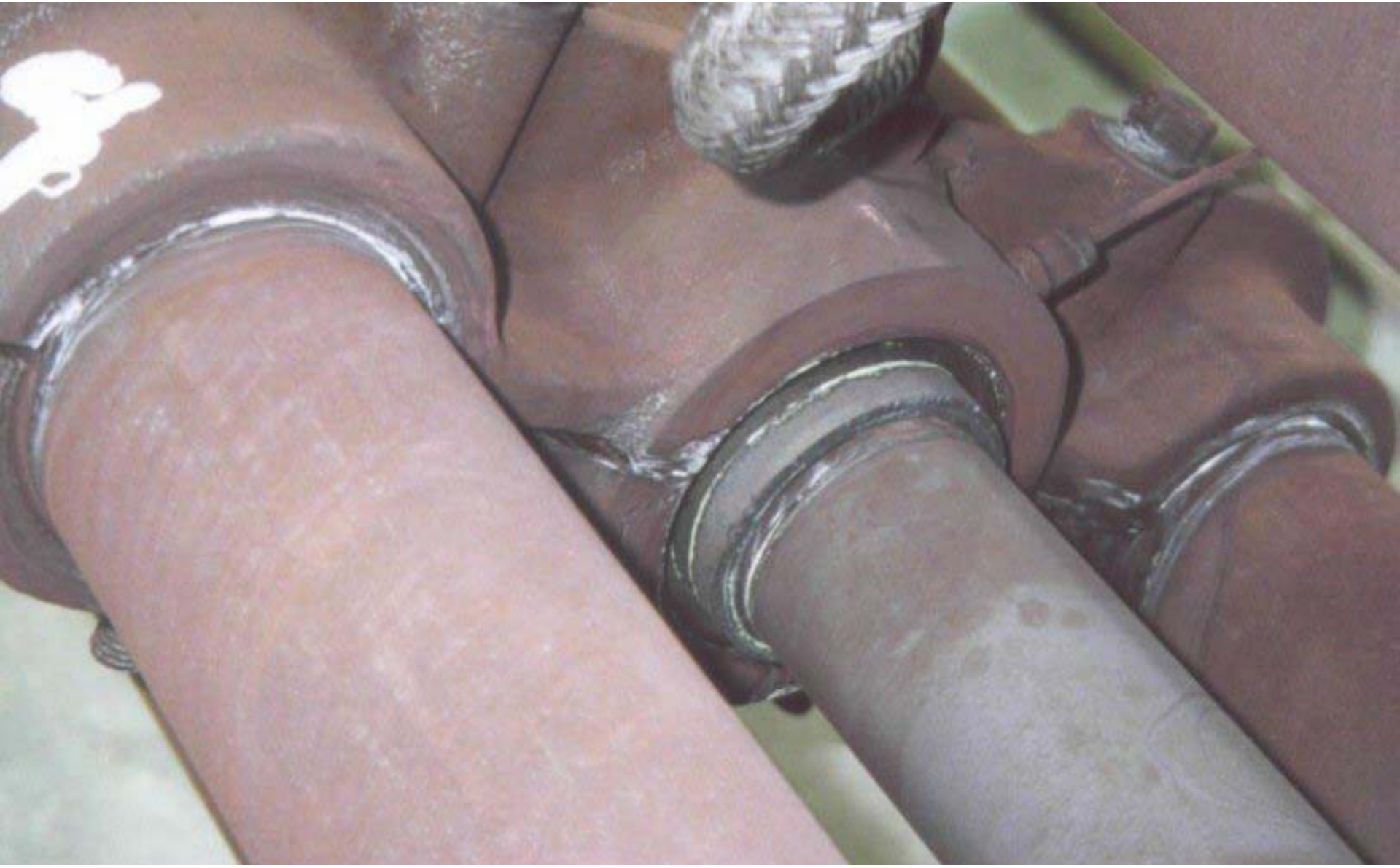
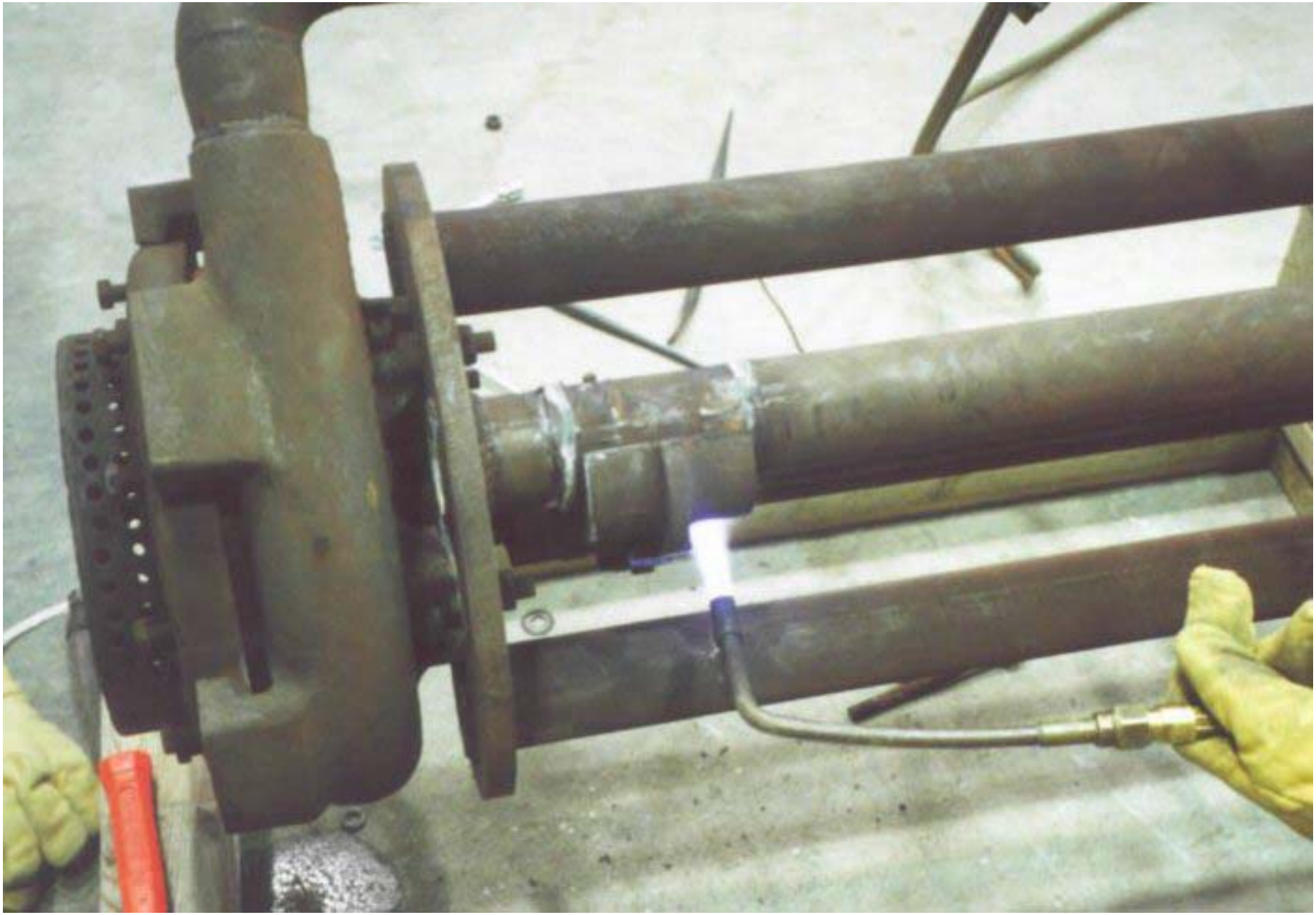
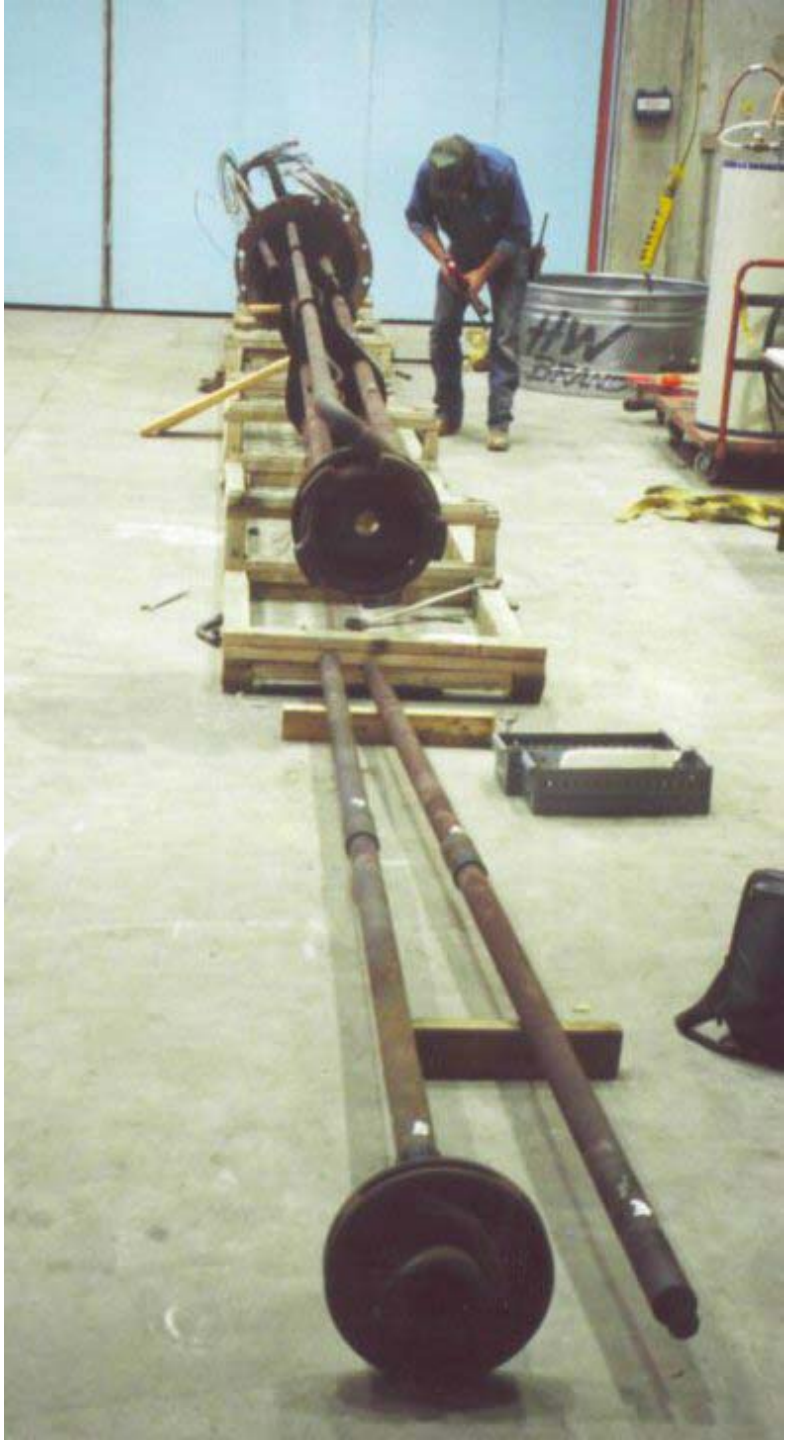


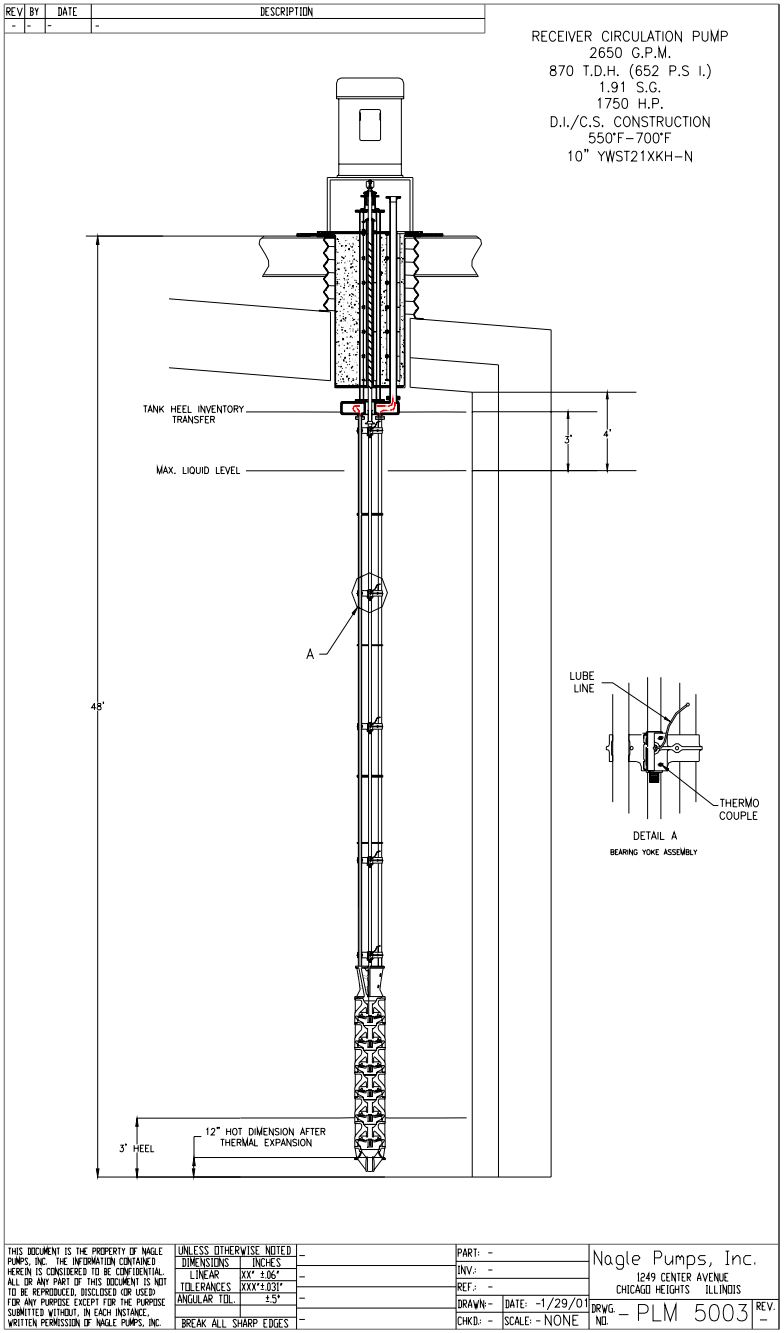




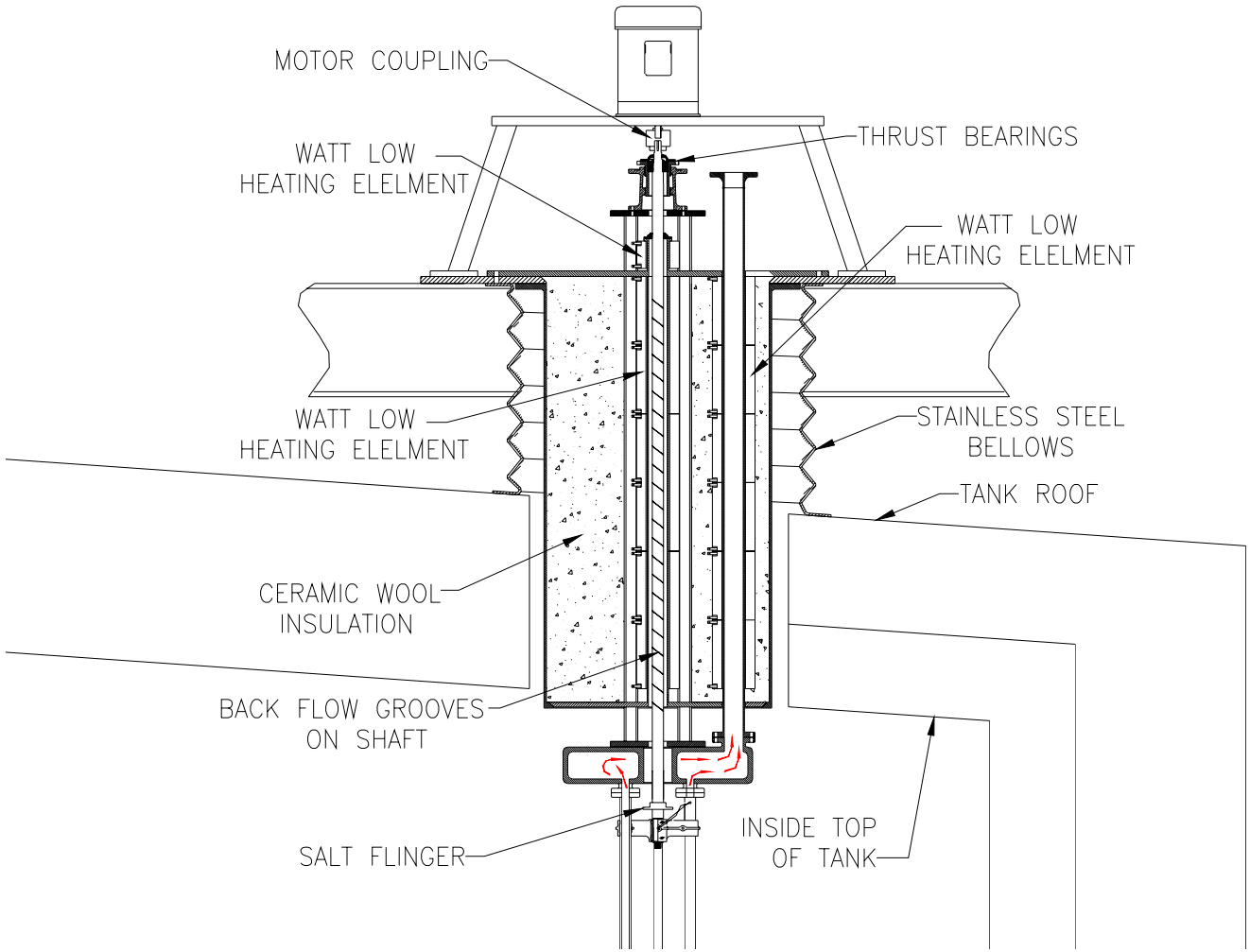
# Implications of the Results

- Pump lengths of 15 m can be commercially built for mounting above the storage tanks in a molten salt power tower.
- Heat loss will be reduced by 10 to 20% over the previous design because the pump sumps, valves, and interconnecting piping will be eliminated. The capital cost of the storage system will be reduced as well.
- This pump design can also be used in parabolic trough plants that use molten salt thermal storage.

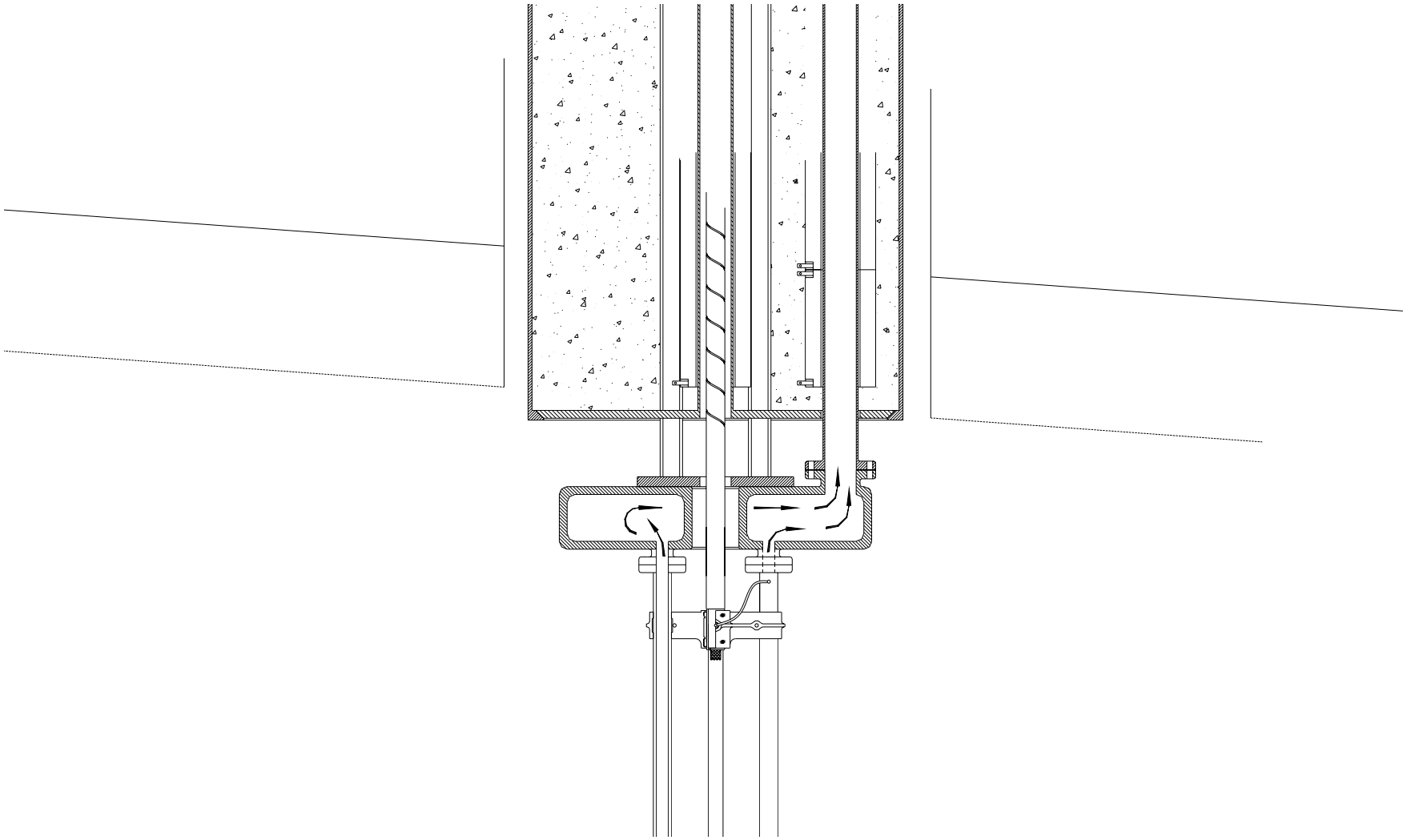
# Vertical Submerged Bearing Pumps up to 50 Feet will be the most cost effective approach.



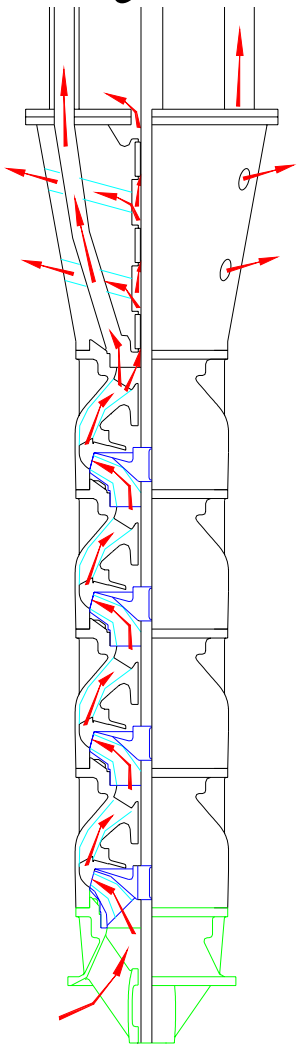
# Details of Sealing Area on top of tank



# Discharge Ring



# Bowl Assembly and Hydro Seal



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